BIOLOGICAL SURVEY OF THE WATERS RECEIVING WASTES FROM SHERMAN MINE, TEMAGAMI

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Ministry of the Environment

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BIOLOGICAL SURVEY

of the

WATERS RECEIVING WASTES

FROM SHERMAN MINE, TEMAGAMI

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SUMMARY

The results of an evaluation of biological parameters and related water quality in the vicinity of Sherman Mine adjacent to Lake Timagami have shown that the mining operation is not significantly affecting aquatic communities in the waters receiving treated waste discharge, except directly adjacent to the overflow point at Vermilion Lake. Specifically, the abundance and distribution of aquatic organisms has not been seriously disturbed downstream of the initial discharge point.

The company officials are to be commended on the handling of wastes from the mining operation. Any mining operation poses a potential hazard to receiving waters since a large volume of wastes is associated with mining activity. Care must be taken to prevent any accidental spill of tailings or the discharge of overflow water high in suspended solids and/or other chemical parameters. The importance of recreational water use in the Lake Timagami area makes it imperative that the quality of the discharge must not significantly change the biological and physio-chemical characteristics of the receiving waters.

Some evidence of a slight reduction in pH is apparent from the chemical analyses of water samples. Since waters in the Precambrian Shield are poorly buffered, any discharge of acid (low pH) waters must be prevented to ensure that the waters are adequately protected.

Recommendations

1. Biological and water chemistry parameters should be investigated periodically by the OWRC to ensure that significant alterations do not occur in the future. Reference to Table V of the Appendix will provide an indication of present water quality conditions (1969). The existing biological conditions in the receiving waters are indicated in this report and will serve as a reference to which future survey conditions may be compared.

2. Sherman Mine should continue to sample the stations indicated in Table V of the Appendix on a bimonthly basis and provide copies of the results obtained to the Division of Industrial Wastes and the Biology Branch of the OWRC. Samples for hydrogen ion concentration (pH) should be analyzed as soon as possible after collection since significant alterations in pH can occur within a few hours.

INTRODUCTION AND PURPOSE

Information was received by the OWRC in 1965 that Sherman Mine was commencing development of a mining property northeast of Lake Timagami. At a public hearing held at Temagami in November, 1966, the company presented a brief outlining proposals for development and plans for waste containment and disposal [1]. Concern was raised by those attending the meeting that wastes from the operation would affect the water quality of Lake Timagami, which is noted for its excellent sport fishing and its attractiveness as a summer vacation area.

In 1967 and 1968 the Biology Branch of the OWRC undertook a sampling program of the drainage system which would receive treated wastes from the mining operation, as well as that area of the northeast arm of Lake Timagami which might be affected. The purpose of this preliminary survey was to collect background information which would allow an assessment of any alterations in the quality of the receiving waters which might be attributable to the mining operation.

In March, 1969, the overflow from the waste disposal area began discharging from Vermilion Lake (see Figure 2). In July of that year, a repeat of the former survey was carried out to determine and assess any changes which might have occurred as a result of the waste discharge.

The purpose of this report is to; 1) assess the effects of mining operations to August, 1969, on the biological community in the waters receiving wastes from Sherman Mine; 2) document conditions in the area to facilitate aquatic biological future evaluations.

DESCRIPTION OF STUDY AREA

Figure 1 is a map of the area adjacent to Sherman Mine and Lake Timagami. The mine is located near the Town of Temagami in the District of Nipissing in a small watershed which flows to Lake Timagami via the Tetapaga River. The area is part of the Precambrian Shield of Ontario where the waters are typically poorly buffered and are most susceptible to the adverse effects of pollution [2]. Lake Timagami and vicinity constitutes a popular and heavily used recreational area which supports numerous resorts and depends on good quality fishing as a source of attraction. It is most important that Lake Timagami and area should be adequately protected for recreational water use.

DESCRIPTION OF THE MINING OPERATION

Figure 2 illustrates the area within which the mining activity of Sherman Mine is progressing. Iron ore is removed from several open-pit sites for delivery to the mill where it is crushed and the magnetite (iron oxide) is separated by magnetic separation and then pelletized. The ore is shipped in this form by rail to the Dofasco Steel Works at Hamilton. The waste consists of finely ground rock fragments - predominantly chert, having 8 to 10% total iron content and ranging in size from 20-500 mesh [1].

FIGURE 1 - MAP OF LAKE TIMAGAMI AREA SHOWING SHERMAN MINE DEVELOPMENT

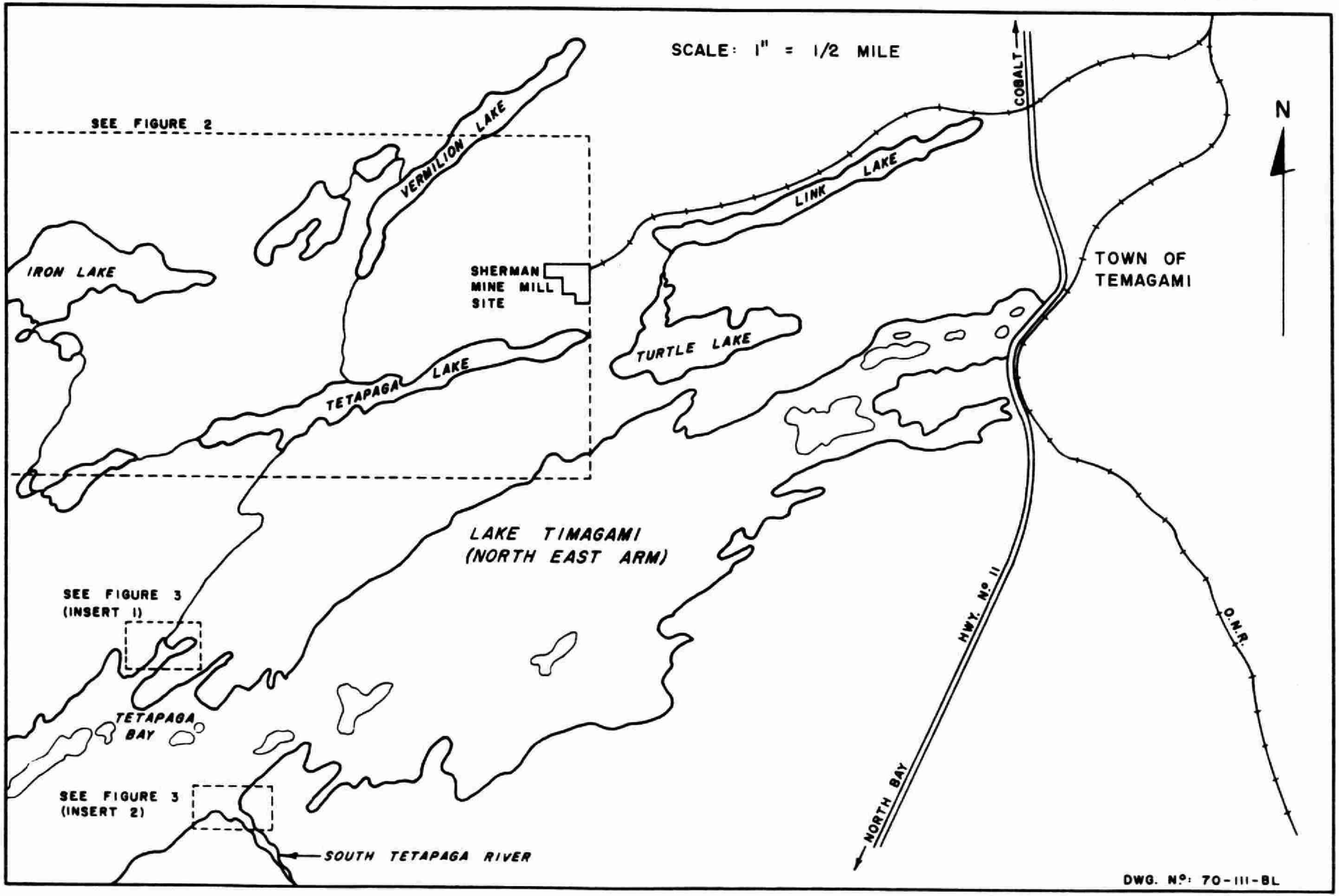
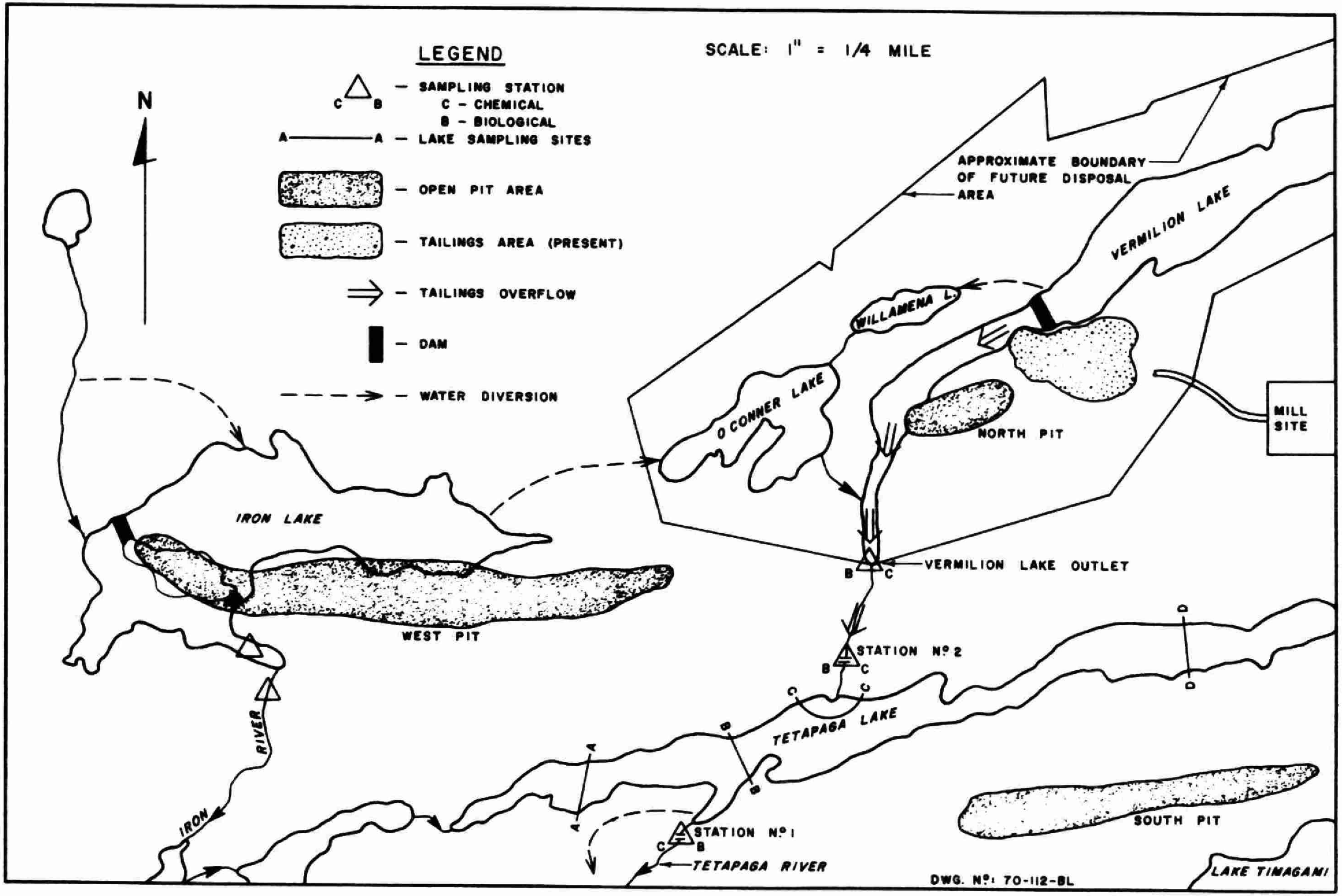


FIGURE 2 - MAP OF SHERMAN MINES DEVELOPMENT INDICATING SAMPLING STATIONS AND DRAINAGE PATTERN



Water from Lake Tetapaga is used as a medium to carry the ground ore throughout the mill circuits and in transporting the pulverized wastes to a tailings thickener and then to the tailings disposal area. The retention time of the tailings slurry (tailings and water) in the disposal area allows the finely ground rock to settle and the excess water overflows to weir into the receiving stream.

The present tailings area is adjacent to Vermilion Lake (Figure 2) and the tailings effluent flows via Willamena and O'Connor lakes to the south end of Vermilion Lake then through a small creek to Tetapaga Lake and thence via the Tetapaga River to Lake Timagami. Eventually the tailings storage volume will amount to 1,350 acre-feet and cover the area indicated in Figure 2 including O'Connor, Willamena and Vermilion lakes.

Certain changes have been made in the flow patterns and lakes in the area adjacent to the mining area. These alterations are shown in Figure 2.

INTERPRETATION OF BIOLOGICAL DATA

In a biological survey, emphasis is placed on documenting qualitative and quantitative changes in the aquatic ecology which are related to alterations in water quality caused by the impact of the discharge of wastes on receiving waters. The aquatic community including bottom-dwelling insects and other invertebrate life (macroinvertebrates) which inhabit lakes and streams are sensitive to

alterations in water quality. Some organisms are adapted to living in only 'clean water' and others are 'pollution-tolerant': therefore, any significant alteration in water quality will induce certain changes in the aquatic community structure. Biological assessment of these changes provides a reliable yardstick suitable for measuring water quality and the detrimental effects of waste discharge.

This approach reflects even small changes in water quality and the results may be influenced by conditions over a considerable period of time prior to the survey. The data collected are supported by chemical and physical analyses of the water which provide an instantaneous measure of water quality.

METHODS

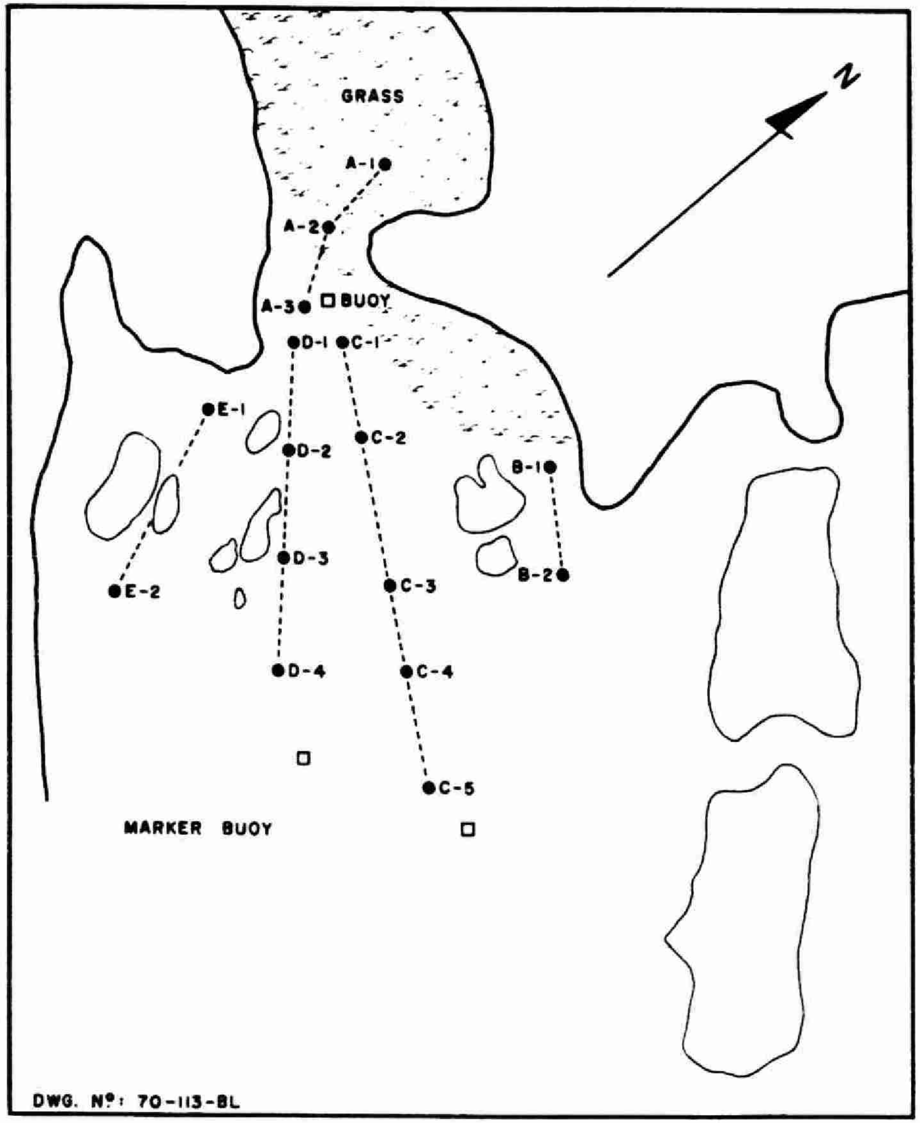
Bottom Fauna Communities

The bottom fauna communities of selected stream and lake stations were investigated in 1967; selected stream stations were sampled in 1968 and 1969. The stations are shown in Figure 2 and 3. A series of reference stations at the mouth of the South Tetapaga River which enters the northeast arm of Lake Timagami from the south was sampled in 1967. All data collected in 1967 and 1968 is background or reference information since overflow of the tailings disposal area did not occur until March, 1969.

Samples of bottom sediments were dredged from lake station (Figures 2 and 3) by means of an Eckman dredge (9" x 9") in August, 1967. The sediments were sieved

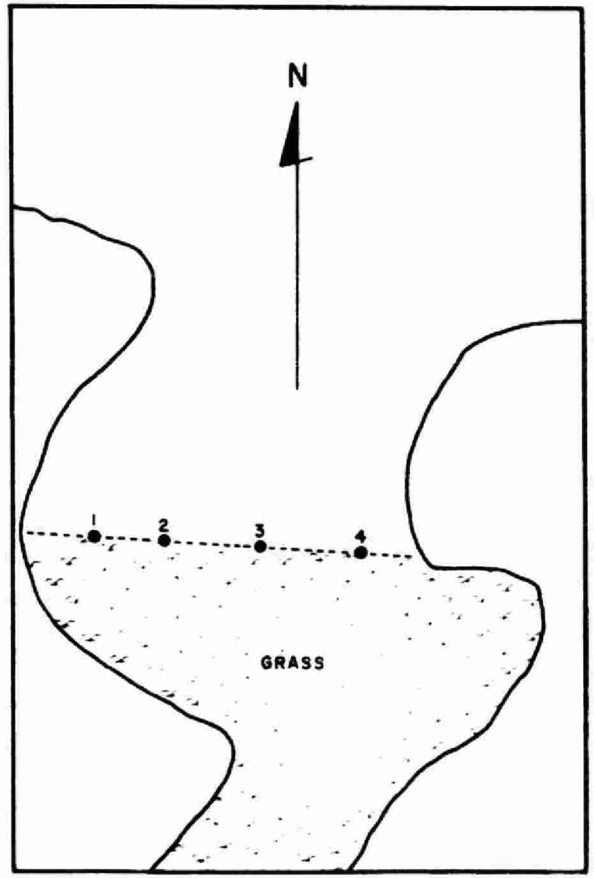
FIGURE 3 - BOTTOM FAUNA SAMPLING STATIONS, LAKE TIMAGAMI

INSERT Nº 1 - MOUTH OF TETAPAGA RIVER AND TETAPAGA BAY, LAKE TIMAGAMI



SCALE: 1" = 80 YARDS

INSERT Nº 2 - MOUTH OF SOUTH TETAPAGA RIVER



through a 20-mesh-to-the inch box screen. Macroinvertebrates retained in the box screen were preserved in 70% ethanol for subsequent identification and enumeration.

Selected stream stations were investigated in August in 1967, 1968 and 1969 with a Surber sampler which quantitatively samples one square foot of bottom. Additional qualitative collections in the same area were made by washing bottom material through hand sieves. The invertebrates collected were preserved in 70% ethanol for subsequent identification and enumeration.

Water Samples

Water samples were collected at the time of the survey and sent to the OWRC laboratory in Rexdale. The analyses and results of testing are indicated in Table V of the Appendix. The post operational testing (after March, 1969) was done by Technical Service Laboratories (T.S.L.) on samples collected by Sherman Mine personnel.

SURVEY FINDINGS

Stream Bottom Fauna

Table III of the Appendix indicates the results of the identification and enumeration of stream bottom samples collected during the 1967 and 1968 surveys - before the tailings discharge overflow from the milling operation reached the receiving waters. Table IV of the Appendix indicates the results of the post-discharge survey

in 1969. These data (Table III and IV) are summarized below:

Table I - Summary of Stream Bottom Fauna Data

		NUMBER OF TAXA			NUMBER OF INDIVIDUALS		
Date August	Status of operation	Sta. #1	Sta. #2	Sta. #3	Sta. #1	Sta. #2	Sta. #3
1967	Pre	11	8		101	130	
	discharge	9	10		83	136	
1968		8	8		156	156	
		5	7		208	40	
1969	Post	44	11	5	1012	78	98
	discharge		10			45	

Comparison of the summarized data in Table I for pre-and post-operational periods reveals that the aquatic invertebrate community has not been significantly altered by waste discharge. The variability noted in the table can be attributed to sampling error and the normal variability within bottom fauna communities. At Station #2 which is only a short distance downstream of the overflow from Vermilion Lake, the community was represented by a maximum of 11 taxa of invertebrates including large numbers of caddisfly larvae and the 'pollution sensitive' taxa - immature mayflies. The same taxa of organisms were present in the 1969 post-operational survey.

The station at the outlet of Vermilion Lake was not sampled in 1967 or 1968 in the background surveys but if the results for that station are compared with either Station 1 or Station 2, it is evident that the stream faunal community has been altered by the waste discharge.

The only forms present were those which are tolerant to pollution. The 'clean-water' taxa and diverse communities represented in the downstream stations are absent from this site close to the overflow from the tailings disposal area.

Water Chemistry

A summary of the results of the chemical and physical analysis of water samples is shown in Appendix Table V. The mean concentration of the various parameters is shown below for three stream stations.

Table 2. Mean Concentration of Chemical Parameters Proximinal to the Tailings Overflow

	VERMILION LAKE OUTLET		Station #2		Station #1	
	Pre	Post	Pre	Post	Pre	Post
Total Solids ppm	239	286	182	289	110	163
Suspended Solids ppm	26	12	3	18	33	20
Dissolved Solids ppm	213	273	179	272	107	169
pH	7.8	7.4	7.7	7.2	7.7	7.2
Turbidity ppm	19	3	414	10	416	3
Hardness ppm	129	201	119	191	68	120
Total iron ppm	0.97	0.5	0.25	0.6	0.25	0.5

An increase in the dissolved solids concentration of up to 50% and a decrease in the average pH (measured at the laboratory) of up to 15% was observed at the Vermilion Lake outlet after the commencement of discharge from the tailings area. No significant increase in the mean total iron concentration was observed indicating that the tailings impoundment

was adequately settling most of the iron lost during the milling process. An apparent increase in turbidity was observed at Station 2. However, water diversion activities in the area had periodically changed the turbidity of the watershed prior to overflow from the tailings impoundment commenced in March, 1969.

REFERENCES CITED

1. ----------------, 1966, Statement by Cliffs of Canada Limited, Manager for Sherman Mine, Temagami, Ontario concerning Industrial Waste Disposal Control Measures. A brief presented at the public hearing in November, 1966, Temagami. OWRC files.

2. Conroy, N., 1970. Biological Survey of the Effects of Uranium-milling wastes in Ontario. OWRC report (in press).

APPENDIX

Table I. Bottom fauna from Lake Timagami, August, 1967 - Numbers of organisms per square foot.

STATION	A-1	A-11	A-2	A-22	A-3	A-33	B-1	B-11	B-2	B-22	C-1	C-11	C-2	C-22	C-3	C-33	C-4	C-44	C-5	C-55	D-1	D-11	D-2	D-22	D-3	D-33	D-4	D-44	E-1	E-11	E-2	E-22
LEECH					2									2																		
Thermyzon meyeri			2																													
CLAM																																
Sphaerium															2																	
AMPHIPOD																																
Hyalella azeteca	9	14	2	42	9						14	5		2	2																	
MAYFLY																																
Hexagenia	2	5	3	3	2						3	2			2															2	2	2
Caenis			11																													
DRAGONFLY																																
Agrionidae				2																												
FISHFLY																																
Sialis		2									2	2							2									2	2			
CADDISFLY																																
Chimarra			3	2	2																											
DIPTERA																																
Culicoides																									2	2						
MIDGE																																
Larvae		9	39	15	9						8	8		5							2				2			2	3			
Pupae																													2			
MITE			2																													
No. of Taxa	2	4	5	6	5	0	0	0	0	0	4	4	0	3	3	0	0	0	1	0	1	0	0	0	2	1	0	2	3	1	1	1
No. of Individuals	11	30	82	66	24	0	0	0	0	0	27	17	0	9	6	0	0	0	2	0	2	0	0	0	4	2	0	4	7	2	2	2

Table II. Bottom fauna from Tetapaga Lake, August 1967 - Number of organisms/square foot.

STATIONS	A-1a	A-1b	A-2a	A-2b	A-3a	A-3b	A-4a	A-4b	B-1a	B-1b	B-2a	B-2b	B-3a	B-3b	B-4a	B-4b	C-1a	C-1b	C-2a	C-2b	C-3a	C-3b	C-4a	C-4b	C-5a	C-5b	D-1a	D-1b	D-2a	D-2b	D-3a	D-3b	D-4a	D-4b
LEECH																																		
Erpobdellidae													2																					
WORM																																		
Tubifex tubifex										2											2		2											
Limnodrilus	2																																	
SNAIL																																		
Aplexa lypnonum					2																													
Gyraulus parvus										2																								
AMPHIPOD																																		
Hyallela azteca		9	36	6	5	75	3																											
MAYFLY																																		
Baetis		2								2																								
Hexagenia															9	6					2													
DRAGONFLY																																		
Amphiagrion						2																												
FISH FLY																																		
Sialis															2	2																		
CADDISFLY																																		
Cyrnellus			5		5	2																												
DIPTERA																																		
Chaoborus	3									9				2	2		50	21		3	84	53	23	27	9	8	20	11	5		5	8	5	6
Culicoides		2																		2		3												
MIDGE		6	14	2		75	5		5	20	3	6	2	6	5	11	5	9	3	5	2	2		2	2	11	2	2				5	6	5
MITE			2			5						2			2		8	2																
No. of Taxa	2	4	4	2	3	5	2	0	2	5	1	2	2	2	5	3	3	3	1	4	3	3	2	2	2	2	2	2	1	0	1	2	2	2
No. of Individuals	5	19	57	8	12	159	8	0	7	35	3	8	4	8	20	19	63	32	3	12	88	58	25	29	11	19	22	13	5	0	5	13	11	11

Table III. Stream invertebrates from two stations near Sherman Mine development - pre discharge period.

	Station #1				Station #2			
AUGUST	1967	1968	1967	1968	1967	1968	1967	1968
Nematode	1			2				
Planaria	24		5					
LEECH								
Erpobdellidae					X	1		1
SNAIL								
Valvata					8			
CLAM								
Sphaerium					1	1		
AMPHIPOD								
Hyallela azteca	2		3					1
CLADOCERA								
Daphnia			1					
CRAYFISH								
Orconectes propinquois							X	
MAYFLY								
Heptagenia	11		2					
Baetis		21	7		2	4	1	
Paraleptophlebia						2		
DRAGONFLY								
Coenagrion	1							
Ophiogomphus	1							
Progomphus					1			
STONEFLY								
Neoperla			X					
BEETLE (adult)			X					
CADDISFLY								
Hydropsyche	37	37	18	4	87	128	121	25
Hydropsyche pupa		3				1		
Polycentropus			3		2			
Chimarra	2		X			6	1	

Table III. continued

AUGUST	Station #1				Station #2			
	1967	1968	1967	1968	1967	1968	1967	1968
DIPTERA								
Phalacrocera		3						
Athrix		2			3	4	2	1
Cnephia	14	47	10	197	17	1		3
Prosimulium							7	
Culicoides		1						
Chaoborus								1
MIDGE (Larvae)	6	42	29	4	8	9	2	8
(Pupa)	1		3		2			
MITE	1						1	
FISH								
Cottus cognatus				1				
Number of Taxa	11	8	9	5	8	10	8	7
Number of Individuals	101	156	83	208	130	153	136	40

Collected with Surber Sampler
X = Additional taxa collected with hand sieve, 1967.

Table IV. Stream invertebrates from stations near Sherman Mine development - post discharge period.

August	Station #1 1969	Station #2 1969	1969	Vermilion Lake Outlet 1969
NEMATODE				
WORM				1
Eclipidrilus		1		
LEECH				
Erpobdellidae	1			
CLAM				
Sphaerium		X	X	
SNAIL				
Physa gyrina	X			
AMPHIPOD				
Hyalella azteca	2			
MAYFLY				
Baetis	3	9	14	
Heptagenia		1	X	
BEETLE				
Larva	1	X	X	
Ochthebius (adult)	1			
HEMIPTERA				
Hesperocorixa (adult)	X			
CADDISFLY				
Chimarra		1	2	
Halesus	X			
Hydropsyche	935	43	19	7
Pupa	18	6		X
DIPTERAN				
Atherix		X	X	
Rhaphidolabis			3	
Simulium	3	4	2	78
MIDGE (Larvae)	47	7	5	12
(Pupa)	1			
ACARI (mites)		1		
FISH				
Hadropterus maculatus				X
No. of Taxa	11	11	10	5
No. of Individuals	1012	72	45	98

Collected with Surber sampler - X=additional taxa collected with hand sieve.

Table V. Summary of analyses of water samples from Sherman Mine Discharge Area.

		Vermilion Lake Outlet Pre	Vermilion Lake Outlet Post	Station #2 Pre	Station #2 Post	Station #1 Pre	Station #1 Post	Iron River Pre	Iron River Post	Tetapaga Lake Pre	Tetapaga Bay Pre
Number of samples		6	7	15	9	22	9	18	5	4	2
Total solids ppm	High	268	320	282	357	180	210	420	236	97	110
	Low	212	198	116	241	18	160	38	144	74	94
	Mean	239	286	182	289	110	163	135	182	85	102
Suspended solids ppm	High	98	25	6	32	11	80	120	14	3	50
	Low	2	2	1	1	1	2	1	5	0	2
	Mean	26	12	3	18	33	20	13	11	1.5	
Dissolved solids ppm	High	265	312	279	350	174	204	418	222	94	108
	Low	166	175	115	211	17	130	36	139	74	44
	Mean	213	273	179	272	107	169	123	171	84	
pH	High	8.2	7.9	8.2	7.8	8.2	7.5	8.8	7.4	7.2	
	Low	7.5	6.6	7.3	6.9	7.1	6.9	7.6	6.9	6.9	
	Mean	7.8	7.4	7.7	7.2	7.7	7.2	7.9	7.2	7.05	7.5
Turbidity ppm	High	50	5	16.0	50	20	5	29.0	5		3.6
	Low	1.4	2	0.5	3	1.1	2	1.8	3		1.5
	Mean	19	3	4.4	10	4.6	3	6.5	4		2.1
Apparent colour units	High	50	13	50	30	70	35	85	40		
	Low	25	10	15	13	20	17	10	22		
	Mean	31	12	30	19	33	27	32	30		
Hardness ppm	High	156	239	164	272	92	142	304	103		
	Low	110	158	68	160	46	108	36	88		
	Mean	129	201	119	191	68	120	73	94		
Total Iron (Fe) ppm	High	2.4	1.0	0.7	1.0	0.6	1.0	0.78	0.4	0.1	0.1
	Low	0.15	0.1	0.1	0.1	0.04	0.1	0.10	0.3		0.07
	Mean	0.97	0.5	0.25	0.6	0.25	0.5	0.34	0.4		0.09